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CHEMICAL ABSTRACTS, vol. 102, 1985, page 19, abstract no. 39565n, Columbus, Ohio, US; M.A. WAQAR et al.: "Effects of 2',3'-dideoxynucleosides on mammalian cells and viruses"

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PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE USA, vol. 83, March 1986, pages 1911-1915, Washington, DC, US; H. MITSUYA et al.: "Inhibition of the in vitro infectivity and cytopathic effect of human T-lymphotrophic virus type III/lymphadenopathy-associated virus (HTLV-III/LAV) by 2',3'-dideoxynucleosides"

Description

The present invention relates to 2',3'-dideoxy-nucleosides, pharmaceutically acceptable derivatives thereof, and their use in therapy, particularly for the treatment or prophylaxis of certain viral infections.

In the comparatively new field of antiviral chemotherapy, few drugs exist which effectively combat the virus per se, owing to the difficulty of attacking the virus while leaving uninfected host cells unimpaired. It has recently been established that certain stages in the virus life-cycle, which vary from species to species, are specified by the virus itself. These stages may prove susceptible to attack where they differ sufficiently from any corresponding host-cell function. However, owing to great similarity between viral and host functions, effective treatments have proven very difficult to identify.

One group of viruses which has recently assumed a particular importance are the retroviruses. Retroviruses form a sub-group of RNA viruses which, in order to replicate, must first 'reverse transcribe' the RNA of their genome into DNA ('transcription' conventionally describes the synthesis of RNA from DNA). Once in the form of DNA, the viral genome is incorporated into the host cell genome, allowing it to take full advantage of the host cell's transcription/translation machinery for the purposes of replication. Once incorporated, the viral DNA is virtually indistinguishable from the host's DNA and, in this state, the virus may persist for as long as the cell lives. As it is virtually invulnerable to attack in this form, any treatment must be directed at another stage of the virus life cycle and will, of necessity, have to be continued until all virus-infected cells have died.

HTLV-I and HTLV-II are both retroviruses and are known to be causative agents of leukaemia in man. HTLV-I infections are especially widespread and are responsible for many deaths world-wide each year.

A species of retrovirus has also been reproducibly isolated from patients with AIDS. The virus was originally known as human T-cell lymphotropic virus III (HTLV III), AIDS associated retrovirus (ARV), lymphadenopathy associated virus (LAV), or acquired immune deficiency virus (AIDV). The internationally agreed name for the virus is now Human Immunodeficiency Virus (HIV). This virus (referred to herein as HIV) has been shown preferentially to infect and destroy T-cells bearing the OKT⁴ surface marker and is now generally accepted as the aetiological agent of AIDS. The patient progressively loses this set of T-cells, upsetting the overall balance of the immune system, reducing his ability to combat other infections, and predisposing him to opportunistic infections which frequently prove fatal. Thus, the usual cause of death in AIDS victims is by opportunistic infection, such as pneumonia or virally induced cancers, and not as a direct result of HIV infection.

Recently, HIV has also been recovered from other tissue types, including B-cells expressing the T⁴ marker, macrophages and non-blood associated tissue in the central nervous system. This infection of the central nervous system has been discovered in patients expressing classical AIDS symptoms and is associated with progressive demyelination, leading to wasting and such symptoms as encephalopathy, progressive dysarthria, ataxia and disorientation. Further conditions associated with HIV infection are the asymptomatic carrier state, progressive generalised lymphadenopathy (PGL) and AIDS-related complex (ARC).

Reports have described the testing of compounds against various retroviruses, for example, Murine Leukaemia Virus (MuLV) a mouse retrovirus. M.A. Waqar et al. (J. Cell. Phys., 121 (1984) 402-408) found that the 2',3'-dideoxyribonucleosides of adenine, cytosine, thymine and guanine inhibited infections of cell-lines by MuLV, but no clear indication of therapeutic potential was given.

In Proc. Natl. Acad.Sci. U.S.A. Vol.83 p1911-1915, March 1986, dideoxynucleosides such as that of guanine, cytosine and inosine are reported as having suppressed the infectivity and the cytopathic effect Of HTLV III/LAV in vitro at concentrations that do not effect the growth and immune function of T. cells. The reference however, makes no mention to hepatitis B testing nor does it mention the combination of any dideoxynucleoside with other compounds.



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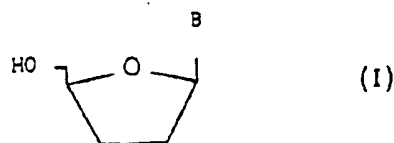
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In Biochemistry 1981, 20, 2628-2632, dideoxynucleoside triphosphates, including that of guanosine (ddGTP) were tested for their ability to inhibit adenovirus DNA replication, but there was no disclosure of using ddG in treating HIV or HBV.

We have now discovered that 2',3'-dideoxynucleosides, as referred to below, are useful for the treatment or prophylaxis of viral infections, particularly retroviral infections and especially AIDS.

In a first aspect of the present invention, there is provided 2,6-diaminopurine-9- β -D--2',3'-dideoxy-ribofuranoside and 2-aminopurine-9- β -D--2',3'-dideoxyribofuranoside, or a pharmaceutically acceptable salt, ester, or salt of such ester.

These compounds (2,6-diaminopurine-9- β -D-dideoxyribofuranoside and 2-aminopurine-9- β -D-dideoxyribofuranoside) which are represented by the following formula (I)



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wherein B represents a 2-aminopurine or 2,6-diamino purine base linked to the sugar residue at the 9-position, or a pharmaceutically acceptable salt, ester, or salt of such ester are also for use in the treatment or prophylaxis of a viral infection.

In vitro testing has shown that the compounds according to the invention have particularly good activity against the following viruses: human T-cell lymphotropic viruses (HTLV), especially HTLV-I, HTLV-II and HIV (HTLV-III); feline leukaemia virus, equine infectious anaemia virus and other lentiviruses, as well as other human viruses such as hepatitis B virus and Epstein-Barr virus (EBV). The invention accordingly provides the compounds according to the invention for use in the treatment or prophylaxis of any of the above infections.

Particularly good activity has been observed against those viruses which are retroviruses and also those DNA viruses which, like retroviruses, are incorporated into the host genome during their life-cycle, i.e. retrovirus-like DNA viruses. Thus, there is further provided the compounds according to the invention for use in the treatment or prophylaxis of retroviral, or retrovirus-like infections.

It will be appreciated that the compounds according to the invention may also be used in the manufacture of a medicament for the treatment or prophylaxis of any of the above-mentioned medical or veterinary indications.

Preferred esters of the compound of formula (I) include carboxylic acid esters in which the non-carbonyl moiety of the ester grouping is selected from straight or branched chain alkyl, alkoxyalkyl (e.g. methoxymethyl), aralkyl (e.g. benzyl), aryloxyalkyl (e.g. phenoxymethyl), aryl (e.g. phenyl optionally substituted by halogen, C_1-4 alkyl or C_1-4 alkoxy); sulphonate esters such as alkyl- or aralkylsulphonyl (e.g. methanesulphonyl); and mono-, di- or tri-phosphate esters.

Any reference to any of the above compounds also includes a reference to a pharmaceutically acceptable salt thereof.

With regard to the above-described esters, unless otherwise specified, any alkyl moiety present advantageously contains 1 to 18 carbon atoms, particularly 1 to 4 carbon atoms. Any aryl moiety present in such esters advantageously comprises a phenyl group.

Examples of pharmaceutically acceptable salts of the compounds of formula (I) and pharmaceutically acceptable derivatives thereof include base salts, eg derived from an appropriate base, such as alkali metal (eg sodium), alkaline earth metal (eg magnesium) salts, ammonium and NX_4^+ (wherein X is C_1-4 alkyl). Physiologically acceptable salts of an hydrogen atom or an amino group include salts of organic carboxylic acids such as acetic, lactic, tartaric, malic, isethionic, lactobionic and succinic acids; organic sulfonic acids such as methanesulfonic, ethanesulfonic, benzenesulfonic and p-toluenesulfonic acids and inorganic acids such as hydrochloric, sulfuric, phosphoric and sulfamic acids. Physiologically acceptable salts of a compound of an hydroxy group include the anion of said compound in combination with a suitable cation such as Na^+ , NH_4^+ , and NX_4^+ (wherein X is a C_1-4 alkyl group).

Dideoxynucleosides involved in the present invention, which are either novel and have novel therapeutic uses or are known but have novel therapeutic uses are:

2',3'-dideoxy-guanosine,
2,6-diaminopurine-9- β -D-dideoxyribofuranoside and
2-aminopurine-9- β -D-dideoxyribofuranoside.

The present invention thus further provides the latter two novel compounds for use in therapy (including their salts, ester or salts of such esters).

Specific examples of pharmaceutically acceptable esters of the compound of formula (I) that may be used in accordance with the present invention include the following 5' esters: monophosphate; disodium monophosphate; diphosphate; triphosphate; acetate; 3-methyl-butylate; octanoate; palmitate; 3-chloro benzoate; benzoate; 4-methyl benzoate; hydrogen succinate; pivalate; and mesylate. A specific example of a pharmaceutically acceptable salt is the monosodium salt.

The compounds according to the invention, also referred to herein as the active ingredient, may be administered for therapy by any suitable route including oral, rectal, nasal, topical (including buccal and sublingual), vaginal and parenteral (including subcutaneous, intramuscular, intravenous and intradermal). It will be appreciated that the preferred route will vary with the condition and age of the recipient, the nature



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of the infection and the chosen active ingredient.

In general a suitable dose will be in the range of 3.0 to 120 mg per kilogram body weight of the recipient per day, preferably in the range of 6 to 90 mg per kilogram body weight per day and most preferably in the range 15 to 60 mg per kilogram body weight per day. The desired dose is preferably presented as two, three, four, five, six or more sub-doses administered at appropriate intervals throughout the day. These sub-doses may be administered in unit dosage forms, for example, containing 10 to 1500 mg, preferably 20 to 1000 mg, and most preferably 50 to 700 mg of active ingredient per unit dosage form.

Ideally, the active ingredient should be administered to achieve peak plasma concentrations of the active compound of from about 1 to about 75 μ M, preferably about 2 to 50 μ M, most preferably about 3 to about 30 μ M. This may be achieved, for example, by the intravenous injection of a 0.1 to 5% solution of the active ingredient, optionally in saline, or orally administered as a bolus containing about 1 to about 100 mg/kg of the active ingredient. Desirable blood levels may be maintained by a continuous infusion to provide about 0.01 to about 5.0 mg/kg/hour or by intermittent infusions containing about 0.4 to about 15 mg/kg of the active ingredient.

While it is possible for the active ingredient to be administered alone it is preferable to present it as a pharmaceutical formulation. The formulations of the present invention comprise at least one active ingredient, as above defined, together with one or more acceptable carriers thereof and optionally other therapeutic agents. Each carrier must be "acceptable" in the sense of being compatible with the other ingredients of the formulation and not injurious to the patient. Formulations include those suitable for oral, rectal, nasal, topical (including buccal and sublingual), vaginal or parenteral (including subcutaneous, intramuscular, intravenous and intradermal) administration. The formulations may conveniently be presented in unit dosage form and may be prepared by any methods well known in the art of pharmacy. Such methods include the step of bringing into association the active ingredient with the carrier which constitutes one or more accessory ingredients. In general, the formulations are prepared by uniformly and intimately bringing into association the active ingredient with liquid carriers or finely divided solid carriers or both, and then if necessary shaping the product.

Formulations of the present invention suitable for oral administration may be presented as discrete units such as capsules, cachets or tablets each containing a predetermined amount of the active ingredient; as a powder or granules; as a solution or a suspension in an aqueous or non-aqueous liquid; or as an oil-in-water liquid emulsion or a water-in-oil liquid emulsion. The active ingredient may also be presented as a bolus, electuary or paste.

A tablet may be made by compression or moulding, optionally with one or more accessory ingredients. Compressed tablets may be prepared by compressing in a suitable machine the active ingredient in a free-flowing form such as a powder or granules, optionally mixed with a binder (e.g. povidone, gelatin, hydroxypropylmethyl cellulose), lubricant, inert diluent, preservative, disintegrant (e.g. sodium starch glycolate, cross-linked povidone, cross-linked sodium carboxymethyl cellulose) surface-active or dispersing agent. Moulded tablets may be made by moulding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent. The tablets may optionally be coated or scored and may be formulated so as to provide slow or controlled release of the active ingredient therein using, for example, hydroxypropylmethyl cellulose in varying proportions to provide the desired release profile. Tablets may optionally be provided with an enteric coating, to provide release in parts of the gut other than the stomach. This is particularly advantageous for the compounds of claims 1 and 2, as such compounds are susceptible to acid hydrolysis.

Formulations suitable for topical administration in the mouth include lozenges comprising the active ingredient in a flavoured basis, usually sucrose and acacia or tragacanth; pastilles comprising the active ingredient in an inert basis such as gelatin and glycerin, or sucrose and acacia; and mouthwashes comprising the active ingredient in a suitable liquid carrier.

Formulations for rectal administration may be presented as a suppository with a suitable base comprising for example cocoa butter or a salicylate.

Formulations suitable for vaginal administration may be presented as pessaries, tampons, creams, gels, pastes, foams or spray formulations containing in addition to the active ingredient such carriers as are known in the art to be appropriate.

Formulations suitable for parenteral administration include aqueous and non-aqueous isotonic sterile injection solutions which may contain anti-oxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the intended recipient; and aqueous and non-aqueous sterile suspensions which may include suspending agents and thickening agents. The formulations may be presented in unit-dose or multi-dose sealed containers, for example, ampoules and vials, and may be stored

in a freeze-dried (lyophilized) condition requiring only the addition of the sterile liquid carrier, for example water for injections, immediately prior to use. Extemporaneous injection solutions and suspensions may be prepared from sterile powders, granules and tablets of the kind previously described.

Preferred unit dosage formulations are those containing a daily dose or unit, daily sub-dose, as herein
5 above recited, or an appropriate fraction thereof, of an active ingredient.

The compounds according to the invention may also be presented for use in the form of veterinary formulations, which may be prepared, for example, by methods that are conventional in the art. Examples of such veterinary formulations include those adapted for:-

(a) oral administration, external application, for example drenches (e.g. aqueous or non-aqueous solutions
10 or suspensions); tablets or boluses; powders, granules or pellets for admixture with feed stuffs; pastes for application to the tongue;

(b) parenteral administration for example by sub-cutaneous, intramuscular or intravenous injection e.g. as a sterile solution or suspension; or (when appropriate) by intramammary injection where a suspension or solution is introduced into the udder via the teat;

15 (c) topical application, e.g. as a cream, ointment or spray applied to the skin; or

(d) intravaginally, e.g. as a pessary, cream or foam.

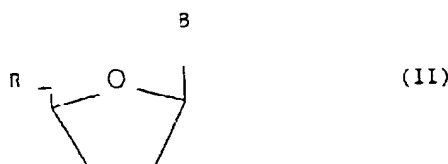
The administered ingredients may also be used in therapy in conjunction with other medicaments such as 9-[[2-hydroxy-1-(hydroxymethyl)ethoxymethyl]guanine, 9-(2-hydroxyethoxymethyl)guanine (acyclovir), 2-amino-9-(2-hydroxyethoxymethyl)purine, interferon, e.g., α interferon, interleukin II, and phosphonoformate,
20 or in conjunction with other immune modulating therapy including bone marrow or lymphocyte transplants or medications such as levamisole or thymosin which would increase lymphocyte numbers and/or function as is appropriate.

It should be understood that in addition to the ingredients particularly mentioned above the formulations of this invention may include other agents conventional in the art having regard to the type of formulation in
25 question, for example, those suitable for oral administration may include such further agents as sweeteners, thickeners and flavouring agents.

2',3'-dideoxyadenosine, 2',3'-dideoxyinosine, 2',3'-dideoxyguanosine and 2',3'-dideoxycytidine are available from P.L. Bicchemicals and may be prepared in conventional manner for example as described in Horwitz et al., J. Org. Chem. 32(3), 817-18 (1967) illustrating the preparation of 2',3'-dideoxycytidine, and
30 Prisbe et al., Synth. Commun. 1985, 15 (5), 401-9 illustrating the preparation of 2',3'-dideoxyadenosine and 2',3'-dideoxyguanosine. Other compounds according to the invention may be prepared in conventional manner, e.g. as described in the Examples.

The present invention further includes a process for the preparation of a compound of formula (I) (i.e. 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside and 2-aminopurine-9- β -D-2',3'-dideoxyribofuranoside)
35 and pharmaceutically acceptable salt, ester, or salt or such esters thereof which comprises either:

(A) reacting a compound of formula:



45 (wherein B represents 2-aminopurine or 2,6-diaminopurine base and R represents a precursor group for the hydroxy group, or for a pharmaceutically acceptable salt, ester or salt of such ester with an agent or under conditions serving to convert the said precursor group into the corresponding desired group; or
(B) reacting a purine or of formula

50 B - H (III)

(wherein B is as hereinbefore defined).

or a functional equivalent thereof, with a compound serving to introduce the desired ribofuranosyl ring at the 9- position of the purine base of formula (III);

and thereafter, or simultaneously therewith, effecting one or more of the following optional conversions:-

(i) when a compound of formula (I) is formed, converting it into a pharmaceutically acceptable salt, ester, or salt of such ester thereof,

(ii) when a pharmaceutically acceptable salt, ester or salt of such ester of a compound of formula (I) is formed, converting the said derivative into a compound of formula (I), or a different salt, ester, or salt of such ester thereof.

In the above-described process according to the invention, it will be appreciated that the precursor compounds of formula (II) as well as the above-mentioned agents and conditions, will be selected from those that are known in the art of nucleoside synthetic chemistry. Examples of such conversion procedures are described hereinafter for guidance and it will be understood that they can be modified in conventional manner depending on the desired compound of formula (I). In particular, where a conversion is described which would otherwise result in the undesired reaction of labile groups then such groups may be protected in conventional manner, with subsequent removal of the protecting groups after completion of the conversion.

With regard to process (A), R may represent a protected hydroxy group e.g. an ester grouping of the type referred to above in relation to formula (I) particularly acetoxy, or an ether group such as a trialkylsilyloxy group, e.g. t-butylidimethylsilyloxy or an aralkoxy group e.g. triphenylmethoxy. Such groups may be converted for example by hydrolysis to the desired hydroxy group or, by transesterification, to an alternative ester group.

With regard to process (B), this may be effected for example by treating an appropriate purine base of formula (III) or a salt or protected derivative thereof, with 2',3'-dideoxythymidine for example in the presence of the appropriate pentosyl transferring enzyme.

The compounds of formula (I) may be prepared, for example, using purine nucleoside phosphorylase and thymidine phosphorylase.

A compound of formula (I) may be converted into a pharmaceutically acceptable phosphate or other ester by reaction with respectively a phosphorylating agent, e.g. POCl_3 or an appropriate esterifying agent, e.g. an acid halide or anhydride. The compound of formula (I), including esters thereof, may be converted into pharmaceutically acceptable salts thereof in conventional manner, e.g. by treatment with an appropriate base. An ester or salt of a compound of formula (I) may be converted into the parent compound, e.g. by hydrolysis.

The following Examples are intended for illustration only and are not intended to limit the scope of the invention in any way. The term 'active ingredient' as used in the Examples means a compound of formula (I) or a pharmaceutically acceptable derivative thereof.

Example 1: Tablet Formulations

The following formulations A and B were prepared by wet granulation of the ingredients with a solution of povidone, followed by addition of magnesium stearate and compression.

Formulation A

	mg/tablet	mg/tablet
(a) Active ingredient	250	250
(b) Lactose B.P.	210	26
(c) Povidone B.P.	15	9
(d) Sodium Starch Glycollate	20	12
(e) Magnesium Stearate	5	3
	500	300

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Formulation B

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10

	mg/tablet	mg/tablet
(a) Active ingredient	250	250
(b) Lactose	150	-
(c) Avicel PH 101®	60	26
(d) Povidone B.P.	15	9
(e) Sodium Starch Glycollate	20	12
(f) Magnesium Stearate	5	3
	500	300

15

Formulation C.

20

25

	mg/tablet
Active ingredient	100
Lactose	200
Starch	50
Povidone	5
Magnesium stearate	4
	<u>359</u>

The following formulations, D and E, were prepared by direct compression of the admixed ingredients. The lactose used in formulation E was of the direct compression type (Dairy Crest - "Zeparox"®).

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Formulation D

35

	mg/tablet
Active Ingredient	250
Pre-gelatinised Starch NF15	150
	400

40

Formulation E

45

50

	mg/tablet
Active Ingredient	250
Lactose	150
Avicel®	100
	500

Formulation F (Controlled Release Formulation)

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The formulation was prepared by wet granulation of the ingredients (below) with a solution of povidone followed by the addition of magnesium stearate and compression.

	mg/tablet
(a) Active Ingredient	500
(b) Hydroxypropylmethylcellulose (Methocel K4M Premium®)	112
(c) Lactose B.P.	53
(d) Povidone B.P.C.	28
(e) Magnesium Stearate	7
	700

Drug release took place over a period of about 6-8 hours and was complete after 12 hours.

Example 2: Capsule Formulations

Formulation A

A capsule formulation was prepared by admixing the ingredients of Formulation D in Example 1 above and filling into a two-part hard gelatin capsule. Formulation B (*infra*) was prepared in a similar manner.

Formulation B

	mg/capsule
(a) Active ingredient	250
(b) Lactose B.P.	143
(c) Sodium Starch Glycollate	25
(d) Magnesium Stearate	2
	420

Formulation C

	mg/capsule
(a) Active ingredient	250
(b) Macrogol 4000 BP	350
	600

Capsules were prepared by melting the macrogol 4000 BP, dispersing the active ingredient in the melt and filling the melt into a two-part hard gelatin capsule.

Formulation D

	mg/capsule
Active ingredient	250
Lecithin	100
Arachis Oil	100
	450

Capsules were prepared by dispersing the active ingredient in the lecithin and arachis oil and filling the dispersion into soft, elastic gelatin capsules.

Formulation E (Controlled Release Capsule)

The following controlled release capsule formulation was prepared by extruding ingredients a, b and c using an extruder, followed by spheronisation of the extrudate and drying. The dried pellets were then coated with release-controlling membrane (d) and filled into a two-piece, hard gelatin capsule.

	mg/capsule
(a) Active Ingredient	250
(b) Microcrystalline Cellulose	125
(c) Lactose BP	125
(d) Ethyl Cellulose	13
	513

Example 3: Injectable Formulation

Formulation A.

Active ingredient		0.200g
Hydrochloric acid solution, 0.1M	q.s. to pH	4.0 to 7.0
Sodium hydroxide solution, 0.1M	q.s. to pH	4.0 to 7.0
Sterile water	q.s. to	10ml

The active ingredient was dissolved in most of the water (35°-40°C) and the pH adjusted to between 4.0 and 7.0 with the hydrochloric acid or the sodium hydroxide as appropriate. The batch was then made up to volume with the water and filtered through a sterile micropore filter into a sterile 10ml amber glass vial (type 1) and sealed with sterile closures and overseals.

Formulation B.

Active ingredient		0.125 g
Sterile, pyrogen-free, pH 7 phosphate buffer,	q.s. to	25 ml

Example 4: Intramuscular injection

Active Ingredient		0.20 g
Benzyl Alcohol		0.10 g
Glycofurol 75®		1.45 g
Water for Injection	q.s. to	3.00 ml

The active ingredient was dissolved in the glycofurol. The benzyl alcohol was then added and dissolved, and water added to 3 ml. The mixture was then filtered through a sterile micropore filter and sealed in sterile 3 ml amber glass vials (type 1).

Example 5: Syrup

5	Active ingredient	0.2500 g
	Sorbitol Solution	1.5000 g
	Glycerol	2.0000 g
	Sodium Benzoate	0.0050 g
	Flavour, Peach 17.42.3169	0.0125 ml
10	Purified Water	q.s. to 5.0000 ml

The active ingredient was dissolved in a mixture of the glycerol and most of the purified water. An aqueous solution of the sodium benzoate was then added to the solution, followed by addition of the sorbitol solution and finally the flavour. The volume was made up with purified water and mixed well.

Example 6: Suppository

20		mg/suppository
	Active Ingredient (63 μ m)*	250
	Hard Fat, BP (Witepsol H15® - Dynamit Nobel)	1770
		2020

*The active ingredient was used as a powder wherein at least 90% of the particles were of 63 μ m diameter or less.

One-fifth of the Witepsol H15 was melted in a steam-jacketed pan at 45°C maximum. The active ingredient was sifted through a 200 μ m sieve and added to the molten base with mixing, using a Silverson fitted with a cutting head, until a smooth dispersion was achieved. Maintaining the mixture at 45°C, the remaining Witepsol H15 was added to the suspension and stirred to ensure a homogenous mix. The entire suspension was passed through a 250 μ m stainless steel screen and, with continuous stirring, was allowed to cool to 40°C. At a temperature of 38°C to 40°C, 2.02g of the mixture was filled into suitable, 2 ml plastic moulds. The suppositories were allowed to cool to room temperature.

Example 7: Pessaries

40		mg/pessary
	Active ingredient (63 μ m)	250
	Anhydrate Dextrose	380
	Potato Starch	363
45	Magnesium Stearate	7
		1000

The above ingredients were mixed directly and pessaries prepared by direct compression of the resulting mixture.

Example 8: 2,6-Diaminopurine-9- β -D-2',3'-dideoxyribofuranoside

2,6-Diaminopurine (9.26 mmoles, 1.39 g) and 2',3'-dideoxythymidine (4.42 mmoles, 1g) were suspended in 50 ml deionized water containing 0.4 ml 1M K₂HPO₄. The pH of the suspension was adjusted to 7.6 with the addition of 0.1 M of KH₂PO₄. The enzyme catalysts purified from *Escherichia coli*, purine nucleoside phosphorylase (1340 I.U.) and thymidine phosphorylase (4450 I.U.) (Kronitsky et al., Biochemistry, 20 3615, 1981 and US Patent 4, 381, 344) were added and the suspension stirred at 35°C. After 18 hours, an additional 2225 I.U. of thymidine phosphorylase was added. Two days later, the reaction was filtered and the filtrate stored at -20°C. Upon thawing, the suspension was adjusted to a pH of 10.6 with

concentrated ammonium hydroxide and chromatographed on a column of Dowex-1-formate® resin (2.5 x 9 cm) with water as the elutant. Fractions containing product were combined and the solvent removed under vacuum. The residue was recrystallised from hot water yielding 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside that analysed as a half hydrate (m.p. 192°).

Anal. Calcd. for C ₁₀ H ₁₄ N ₆ O ₂ · 0.5H ₂ O:	C, 46.33;	H, 5.83;	N, 32.41.
Found:	C, 46.27;	H, 5.83;	N, 32.39

Example 9: 2-Aminopurine-9- β -D-2',3'-dideoxyribofuranoside

2',3'-Dideoxythymidine (4.42 mmoles, 1g), and 2-aminopurine (8.73 moles, 1.18g) were combined in 50 ml deionised water containing 0.4 ml 1M K₂HPO₄. The suspension had a pH of 7.8. Purine nucleoside phosphorylase (2680 I.U.) and thymidine phosphorylase (4500 I.U.) were added and the reaction stirred at 35°C. On day two, additional thymidine phosphorylase (2225 I.U.) was added and one day later the solids were filtered off and the filtrate stored at -20°C. Upon thawing, solids were removed and combined with the original reaction cake. The filtrate was adjusted to pH 10.5 with concentrated ammonium hydroxide and chromatographed on a Dowex-1-formate® column (2.5 x 11 cm). The product was eluted from the resin with water. After recrystallising from boiling water, a small quantity of 2-amino-9- β -D-2',3'-dideoxyribofuranoside was isolated. The remaining solids from the reaction were heated in 25 ml of water to a boil and filtered. This solution was combined with all the liquors from above, the volume reduced, and the solid recrystallised from water. The crystals were combined with the those obtained above to yield a final crop of 2-aminopurine-9- β -D-2',3'-dideoxyribofuranoside half hydrate, m.p. 162°C. Anal. Calcd. for C₁₀H₁₃N₅O₂ · 0.5H₂O: C, 49.17; H, 5.78; N, 28.67. Found; C, 48.97; H, 5.80; N, 28.67.

Example 10: Antiviral Activity

a) Feline Leukaemia Virus

Susceptible feline embryo lung fibroblasts (FLF-3) were seeded onto multiwell slides (10⁵ cells/ml, 0.05 ml/well) with Dulbecco-modified Eagle's essential medium (DME) and incubated at 37°C overnight. Each of the 32 wells was then infected with 40-60 focus forming units (ffu) of feline leukaemia virus (FeLV) for one hour after which the medium was replaced with fresh DMF with varying concentrations of 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside per 4 wells. Concentrations were 0, 1.0, 10, 50, 100, 200 and 400 μ M. After 3 days incubation at 37°C, the cultures were assayed by the indirect fluorescent antigen test for the production of FeLV. Complete absence of FeLV was seen at concentrations of 100 μ M and above, demonstrating total efficacy at these levels of drug. At 50 μ M, 60% inhibition was seen, at 10 μ M, 45% inhibition, and 31% inhibition was noted at 0.1 μ M 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside.

b) HIV

The ability of 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside to block infection of cells by HIV was determined as follows. Cloned T4 positive tetanus specific T helper lymphocytes were infected with a pool of HIV isolates at challenge doses of up to 5000 virions/cell, and cell survival after infection was monitored. After 10 days in culture no viral cytopathic effects were seen in infected T cells treated with 10 and 2 μ M 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside, while untreated, infected cells were 8-fold decreased. This protective effect was seen on both days 10 and 13 of the experiment.

c) Friend Leukaemia virus

The compounds have been tested for retroviral activity against friend leukaemia virus with the following results.

Compound	FD ₅₀ (μ M)
2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside	22.35
2',3'-dideoxyguanosine	25.89

Example 13 Cytotoxicity

The following compounds were tested for cytotoxic effect at 10^{-4} M against human D-98 and mouse L cells. Figures shown are % growth relative to the control.

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Compound	% Growth	
	D-98	L
2,6-diamino-9-(2',3'-dideoxy- β -D-ribofuranosyl)-9H-purine	97	41
2-amino-9-(2',3'-dideoxy- β -D-ribofuranosyl)-9H-purine	97	107
2',3'-dideoxyguanosine	87	93

15 Claims

Claims for the following Contracting States : BE, CH, DE, FR, GB, IT, LI, LU, NL, SE

20

1. 2,6-diaminopurine-9- β -D-2',3'-dideoxyribofuranoside or a pharmaceutically acceptable salt, ester or salt of such ester thereof.

2. 2-aminopurine-9- β -D-2',3'-dideoxyribofuranoside or a pharmaceutically acceptable salt, ester or salt of such ester thereof.

3. A compound as claimed in claims 1 or 2 for use in therapy.

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4. Use of a compound of claims 1 or 2 in the manufacture of a medicament for the treatment or prophylaxis of a Human Immunodeficiency Virus infection.

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5. Use of a compound of claims 1 or 2 in the manufacture of a medicament for the treatment or prophylaxis of a hepatitis-B virus infection.

6. Use of 2',3'-dideoxyguanosine in the manufacture of a medicament for the treatment or prophylaxis of a Human Immunodeficiency Virus infection.

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7. Use of 2',3'-dideoxyguanosine in the manufacture of a medicament for the treatment or prophylaxis of a hepatitis-B virus infection.

8. A pharmaceutical formulation adapted for human administration comprising a compound of claims 1 or 2, together with a pharmaceutically acceptable carrier therefor.

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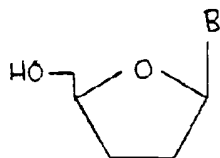
9. A pharmaceutical formulation as claimed in claim 8 in the form of a tablet.

Claims for the following Contracting State : AT

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1. A process for the preparation of a compound of formula (I)

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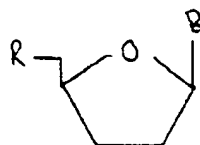


(I)

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wherein B is a 2-aminopurine or 2,6-diaminopurine base linked to the sugar residue at the 9- position, or a pharmaceutically acceptable salt, ester or salt derivative of such ester, which comprises either:

(A) reacting a compound of formula:



(II)

wherein B is as defined and R is a precursor group for the hydroxy group, or for a pharmaceutically acceptable derivative group thereof, with an agent or under conditions serving to convert the said precursor group into the corresponding desired group; or

(B) reacting a purine or cytosine base of formula

B - H (III)

wherein B is as defined;

or a functional equivalent thereof, with a compound serving to introduce the desired ribofuranosyl ring at the 9- position respectively of the purine base of formula (III);

and thereafter, or simultaneously therewith, effecting one or more of the following optional conversions:-

(i) when a compound of formula (I) is formed, converting it into a pharmaceutically acceptable salt, ester or salt of such ester thereof, and

(ii) when a pharmaceutically acceptable salt, ester or salt of such ester of a compound of formula (I) is formed, converting the said derivative into a compound of formula (I), or a different salt, ester or salt of such ester.

2. A process for the preparation of 2,6-diaminopurine-9- β -D-2',3'-dideoxy ribofuranoside according to claim 1.
3. A process for the preparation of 2-aminopurine-9- β -D-dideoxyribofuranoside according to claim 1.
4. A process for the preparation of a pharmaceutical formulation comprising mixing a compound according to claim 1 or 2 with a pharmaceutically acceptable excipient.

Patentansprüche

Patentansprüche für folgende Vertragsstaaten : BE, CH, DE, FR, GB, IT, LI, LU, NL, SE

1. 2,6-Diaminopurin-9- β -D-2',3'-dideoxyribofuranosid oder ein pharmazeutisch annehmbares Salz, ein pharmazeutisch annehmbarer Ester oder ein pharmazeutisch annehmbares Salz eines solchen Esters.
2. 2-Aminopurin-9- β -D-2',3'-dideoxyribofuranosid oder ein pharmazeutisch annehmbares Salz, ein pharmazeutisch annehmbarer Ester oder ein pharmazeutisch annehmbares Salz eines solchen Esters.
3. Verbindung nach den Ansprüchen 1 und 2 zur Verwendung in der Therapie.
4. Verwendung einer Verbindung nach den Ansprüchen 1 oder 2 bei der Herstellung eines Arzneimittels zur Behandlung oder Prophylaxe einer HIV-Infektion (Human Immunodeficiency Virus-Infektion).
5. Verwendung einer Verbindung nach den Ansprüchen 1 oder 2 bei der Herstellung eines Arzneimittels zur Behandlung oder Prophylaxe einer Hepatitis-B-Virus-Infektion.
6. Verwendung von 2',3'-Dideoxyguanosin bei der Herstellung eines Arzneimittels zur Behandlung oder Prophylaxe einer HIV-Infektion (Human Immunodeficiency Virus-Infektion).

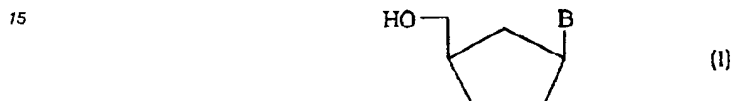
7. Verwendung von 2',3'-Dideoxyguanosin bei der Herstellung eines Arzneimittels zur Behandlung oder Prophylaxe einer Hepatitis-B-Virus-Infektion.

8. Zur Verabreichung an den Menschen geeignete pharmazeutische Zubereitung enthaltend eine Verbindung nach den Ansprüchen 1 oder 2 zusammen mit einem dafür geeigneten pharmazeutisch annehmbaren Träger.

9. Pharmazeutische Zubereitung nach Anspruch 8 in Form einer Tablette.

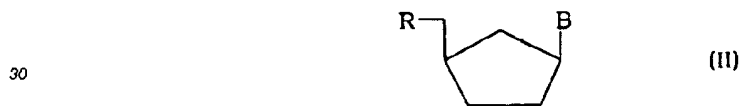
10 Patentansprüche für folgenden Vertragsstaat : AT

1. Verfahren zur Herstellung einer Verbindung der Formel (I)



20 in der B eine 2-Aminopurin- oder 2,6-Diaminopurin-Base bedeutet, die in der 9-Stellung an den Zuckerrest gebunden ist, oder ein pharmazeutisch annehmbares Salz, ein pharmazeutisch annehmbarer Ester oder ein von einem solchen Ester abgeleitetes pharmazeutisch annehmbares Salz, welches darin besteht, entweder:

25 (A) eine Verbindung der Formel



35 worin B die oben angegebenen Bedeutungen besitzt und R eine Vorläufergruppe für die Hydroxylgruppe oder eine davon abgeleitete pharmazeutisch annehmbare Gruppe bedeutet, mit einem Mittel oder unter Bedingungen umsetzt, die dazu dienen, die Vorläufergruppe in die entsprechende gewünschte Gruppe umzuwandeln; oder
(B) eine Purin- oder Cytosin-Base der Formel

40 B-H (III)

in der B die oben angegebenen Bedeutungen besitzt, oder ein funktionelles Äquivalent davon mit einer Verbindung, die dazu dient, den gewünschten Ribofuranosyl-Ring in die 9-Stellung der Purinbase der Formel (III) einzuführen, umzusetzen; und anschließend oder gleichzeitig damit eine oder mehrere der folgenden gegebenenfalls durchzuführenden Umwandlungen zu bewirken:

- 45 (i) wenn eine Verbindung der Formel (I) gebildet worden ist, deren Umwandlung in ein pharmazeutisch annehmbares Salz, einen pharmazeutisch annehmbaren Ester oder ein pharmazeutisch annehmbares Salz eines solchen Esters, und
50 (ii) wenn ein pharmazeutisch annehmbares Salz, ein pharmazeutisch annehmbarer Ester oder ein pharmazeutisch annehmbares Salz eines solchen Esters einer Verbindung der Formel (I) gebildet worden ist, Umwandlung des Derivats in eine Verbindung der Formel (I) oder ein unterschiedliches Salz, einen unterschiedlichen Ester oder ein Salz eines solchen Esters.

55 2. Verfahren zur Herstellung von 2,6-Diaminopurin-9- β -D-dideoxyribofuranosid nach Anspruch 1.

3. Verfahren zur Herstellung von 2-Aminopurin-9- β -D-dideoxyribofuranosid nach Anspruch 1.

4. Verfahren zur Herstellung einer pharmazeutischen Zubereitung, welches darin besteht, eine Verbindung nach Anspruch 1 oder 2 mit einem pharmazeutisch annehmbaren Träger zu vermischen.

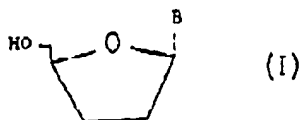
Revendications

5 **Revendications pour les Etats contractants suivants : BE, CH, DE, FR, GB, IT, LI, LU, NL, SE**

1. 2,6-diaminopurine-9- β -D-2',3'-didésoxyribofuranoside ou un sel, un ester ou un sel d'un tel ester pharmaceutiquement acceptable de celui-ci.
- 10 2. 2-aminopurine-9- β -D-2',3'-didésoxyribofuranoside ou un sel, un ester ou un sel d'un tel ester pharmaceutiquement acceptable de celui-ci.
3. Composé tel que revendiqué dans les revendications 1 ou 2 utilisé à des fins thérapeutiques.
- 15 4. Utilisation d'un composé selon les revendications 1 ou 2 pour la fabrication d'un médicament destiné au traitement ou à la prophylaxie de l'infection par le Virus de l'Immunodéficience Humaine.
5. Utilisation d'un composé selon les revendications 1 ou 2 pour la fabrication d'un médicament destiné au traitement ou à la prophylaxie de l'infection par le virus de l'hépatite-B.
- 20 6. Utilisation de la 2',3'-didésoxyguanosine pour la fabrication d'un médicament destiné au traitement ou à la prophylaxie de l'infection par le Virus de l'Immunodéficience Humaine.
7. Utilisation de la 2'-3'-didésoxyguanosine pour la fabrication d'un médicament destiné au traitement ou à la prophylaxie de l'infection par la virus de l'hépatite B.
- 25 8. Formulation pharmaceutique pouvant être administrée à l'homme comprenant un composé selon les revendications 1 ou 2, avec un véhicule pharmaceutiquement acceptable de celui-ci.
9. Formulation pharmaceutique selon la revendication 8 sous forme de comprimé.
- 30

Revendications pour l'Etat contractant suivant : AT

- 35 1. Procédé de préparation d'un composé de formule (I)



dans laquelle B est une base 2-aminopurine ou 2,6-diaminopurine liée au résidu du sucre en position 9, ou un sel, un ester ou un sel dérivé d'un tel ester, pharmaceutiquement acceptable, qui comprend soit :

- 45 (A) la réaction d'un composé de formule:



50 dans laquelle D est tel que défini et R est un groupement précurseur du groupement hydroxy, ou d'un groupement dérivé pharmaceutiquement acceptable de ce groupement, avec un agent ou dans des conditions servant à convertir ledit groupement précurseur sous la forme du groupement désiré correspondant ; ou

(B) la réaction d'une base purique ou de cytosine de formule

B-H (III)

dans laquelle B est tel que défini :

ou un équivalent fonctionnel de celui-ci, avec un composé servant à introduire le cycle ribofuranosyl
5 désiré à la position 9, respectivement de la base purique de formule (III) ;

ensuite, ou en même temps, la réalisation d'une ou plusieurs des conversions possibles suivantes :

(i) lorsque le composé de formule (I) est formé, la conversion de celui-ci en un sel, un ester ou un
sel d'un tel ester pharmaceutiquement acceptable de celui-ci, et

(ii) lorsqu'un sel, un ester ou un sel d'un tel ester pharmaceutiquement acceptable d'un composé
10 de formule (I) est formé, la conversion dudit dérivé en un composé de formule (I), ou un sel, un
ester ou un sel d'un tel ester différent.

2. Procédé pour la préparation du 2,6-diamino-9- β -D-didésoxyribofuranoside selon la formule 1.

15 3. Procédé pour la préparation du 2-aminopurine-9- β -D-didésoxyribofuranoside selon la formule 1.

4. Procédé pour la préparation d'une formulation pharmaceutique selon la revendication 1 ou 2 avec un
excipient pharmaceutiquement acceptable.

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